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TR 67-46

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TECHNICAL REPORT NO. 67-46

OPERATION OF THE UINTA BASIN SEISMOLOGICAL OBSERVATORY

Quarterly Report No. 5

1 May through 31 July 1967

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TECHNICAL REPORT NO. 67-46

OPERATION OF THE UINTA BASIN SEISMOLOGICAL OBSERVATORY - QUARTERLY REPORT NO. 5
1 May through 31 July 1967

Sponsored by

Advanced Research Projects Agency
Nuclear Test Detection Office
ARPA Order No. 624

GEOTECH
A TELEDYNE COMPANY
3401 Shiloh Road
Garland, Texas

17 August 1967

IDENTIFICATION

AFTAC Project No:	VELA T/6705
Project Title:	Operation of UBSO
ARPA Order No:	624
ARPA Program Code No:	6F10
Name of Contractor:	Teledyne Industries, Geotech Division Garland, Texas
Date of Contract:	1 May 1966
Amount of Contract:	$624,897
Contract No:	AF 33(657)-16563
Contract Expiration Date	31 October 1967
Program Manager	B. B. Leichliter, BR1-2561 Garland, Texas

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ABSTRACT

This report describes the operation of the Uinta Basin Seismological Observatory (UBSO) from 1 May 1967 through 31 July 1967. Modifications and additions to the observatory instrumentation are described, and tests to improve the operations of the observatory are reported. Also discussed is the status of special investigations designed to evaluate and improve the detection capability of the observatory.

OPERATION OF THE UINTA BASIN SEISMOLOGICAL OBSERVATORY -
QUARTERLY REPORT NO. 5
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1. INTRODUCTION

1.1 AUTHORITY

The work described in this report was supported by the Advanced Research Projects Agency, Nuclear Test Detection Office, and was monitored by the Air Force Technical Applications Center (AFTAC), under Contract AF 33(657)-16563. The statement of work for this contract is shown in the appendix.

1.2 HISTORY

The Uinta Basin Seismological Observatory (UBSO) was constructed under Contract AF 33(657)-7185. Site selection and noise surveys were accomplished by Geotech; the final decision on the observatory location was made by AFTAC. Texas Instruments, Incorporated (TI) was responsible for the construction of all physical facilities.

Contract AF 33(600)-43486, issued to TI, contained the authority for equipping and operating UBSO. The instrumentation was supplied by Geotech and was installed under the direction of Geotech personnel under subcontract to TI. Texas Instruments operated the observatory from November 1962 until 1 July 1963. Under Projects VT/1124 and VT/5054, Contract AF 33(657)-12373, Geotech operated UBSO from 1 July 1963 through 30 April 1966.

2. OPERATION OF UBSO

2.1 GENERAL

Data are recorded at UBSO on a 24-hour basis. The observatory is normally manned 8 to 10 hours a day, 5 days a week. On weekends and holidays, a skeleton crew mans the observatory 8 hours a day; however, additional personnel are on call in case of emergency.

The UBSO array configuration is shown in figure 1.

Dr. Frank Pilotte of the VELA Seismological Center visited our Garland office on 24 and 25 July to discuss the status of Projects VT/7702 and VT/6705.

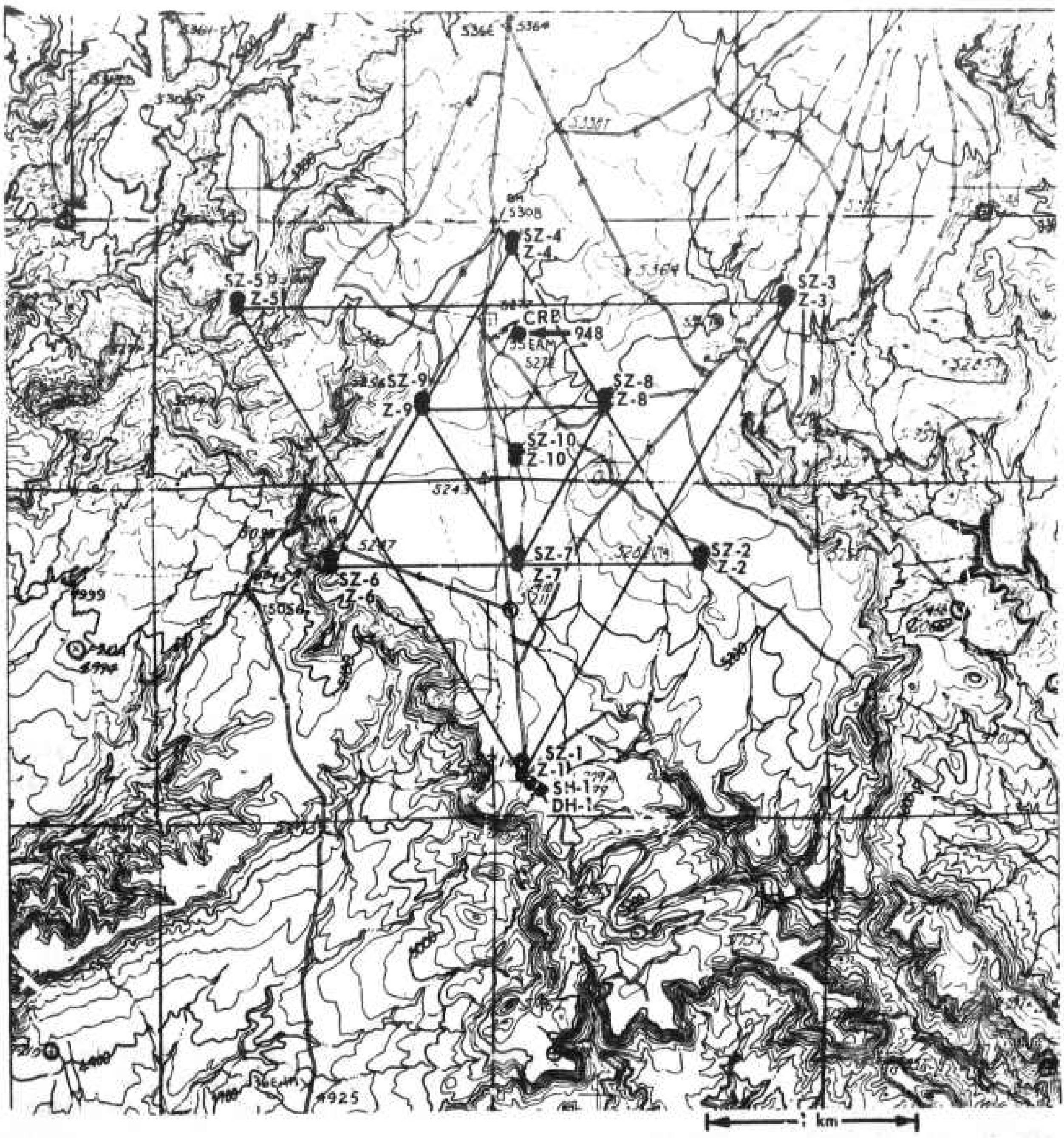

Figure 1. Orientation and configuration of UBSO arrays

G 901

2.2 SEISMOGRAPH OPERATING PARAMETERS

2.2.1 Standard Seismographs

The operating parameters and the tolerances for the standard observatory seismographs are shown in table 1. These parameters are reset, as necessary, when the frequency response of a seismograph is found to be out of tolerance. The frequency response norms and their respective tolerances are shown in table 2. The frequency responses of the UBSO seismographs, as normally operated, are shown in figure 2.

2.2.2 Filters for Multiple Array Processors (MAP)

All MAP channels utilize a band-pass filter with the following settings: a high-cut corner frequency of 3 cps at 6 dB per octave cutoff rate, and a low-cut corner frequency of 1 cps at 12 dB per octave cutoff rate.

2.2.3 Filters for Surface and Shallow-Buried Array Summations

Summations of the 10-element surface array and the 10-element shallow-buried array are each filtered by a band-pass filter with the following settings: a high-cut corner frequency of 3 cps and a low-cut corner frequency of 0.8 cps, both at a cutoff rate of 18 dB per octave.

2.2.4 Filters for Vertical Array Summations

The six elements of the vertical array are summed, and two outputs are recorded. Throughout the reporting period, one of the outputs (ΣDH) was operated as an unfiltered summation, and the second output (ΣDHF) was filtered by a band-pass filter with the following settings: a high-cut corner frequency of 3 cps at a cutoff rate of 24 dB per octave and a low-cut corner frequency of 0.75 cps at a cutoff rate of 36 dB per octave.

2.3 DATA CHANNEL ASSIGNMENTS

On 1 July, recording of the outputs of the MAP I systems and of the elements of the surface array was terminated and Data Groups 5076 and 5035 were established. Sixteen-millimeter film Data Group 5076 includes elements SZ1, SZ3, and SZ5 of the shallow-buried array, an unfiltered summation and a filtered summation of the elements of the shallow-buried array, and a three-component short-period system operating at gains of 5K, 60K, and 600K. Magnetic-tape Data Group 5035 includes the outputs of the Sandia Unmanned Seismological Observatory (USO) short-period and long-period vertical seismographs and USO time, a filtered summation of the outputs of the elements of the shallow-buried array, and Multichannel Filters (MCF) 11, 12, and 13 of MAP II. The current data-channel assignments and normal operating magnifications for all UBSO data groups are shown in table 3. The key to the designators used in the data-channel assignments is given in table 4.

Table 1. Operating parameters and tolerances of seismographs at UBSO

Seismograph		Seismometer		Operating parameters and tolerances					Filter settings	
System	Comp	Type	Model	T_s	λ_s	T_g	λ_g	σ^2	Bandpass at 3 dB cutoff (sec)	Cut off rate at SP side (dB/oct)
SP	Z and H	Johnson-Matheson	7515 / 6480	1.25 ±2%	0.51 ±5%	0.33 ±5%	0.65 ±5%	0.03	0.1-100	12
SP	SZ	Geotech	18300	1.25 ±2%	0.51 ±5%	0.33 ±5%	0.65 ±5%	0.053	0.1-100	12
SP	Z	UA Benioff	1051	1.0 ±5%	1.0	0.083 ±5%	≈1.4	1.0	-	-
IB	Z	Melton	10012	2.5 ±5%	0.65 ±5%	0.64 ±5%	1.2 ±5%	0.018	0.05-100	12
IB	H	Geotech	8700B	2.5 ±5%	0.65 ±5%	0.64 ±5%	1.2 ±5%	0.001	0.05-100	12
BB	Z	Geotech	7505	12.5 ±5%	0.485 ±5%	0.64 ±5%	9.0 ±5%	0.0007	0.05-100	12
BB	H	Geotech	8700A	12.5 ±5%	0.485	0.64 ±5%	9.0 ±5%	0.0007	0.05-100	12
LP	Z	Geotech	7505A	20.0 ±5%	0.74 ±5%	110 ±10%	0.85 ±10%	0.63	25-1000	12
LP	H	Geotech	8700A	20.0 ±5%	0.74 ±5%	110 ±10%	0.85 ±10%	0.63	25-1000	12

KEY

SP	Short period	T_s	Seismometer free period (sec)
IB	Intermediate band (currently inactive)	T_g	Galvanometer free period (sec)
BB	Broad band	λ_s	Seismometer damping constant
LP	Long period	λ_g	Galvanometer damping constant
UA	Unamplified (i.e., earth powered)	σ^2	Coupling coefficient

Table 2. Calibration norms and operating tolerances for frequency responses of the standard seismographs at UBSO

SP Vertical 18300 and SP Johnson-Matheson Vertical and Horizontal

f (cps)	T (sec)	R. M.	A. T. (±%)
0.2	5.0	0.0113	10
0.4	2.5	0.0950	7.5
0.8	1.25	0.685	5
1.0	1.0	1.0	-
1.5	0.67	1.52	5
2.0	0.5	1.90	5
3.0	0.33	2.12	7.5
4.0	0.25	1.87	12
6.0	0.167	1.15	20
8.0	0.125		
10.0	0.100		

LP Vertical and Horizontal[c]

f (cps)	T (sec)	R. M.	A. T. (±%)
0.01	100	0.246	20
0.0125	80	0.377	20
0.0167	60	0.589	15
0.02	50	0.745	15
0.025	40	0.899	10
0.033	30	1.06	5
0.04	25	1.0	-
0.05	20	0.822	5
0.0667	15	0.506	10
0.10	10	0.173	20
0.143	7	b	a

IB Vertical and Horizontal

f (cps)	T (sec)	R. M.	A. T. (±%)
0.1	10.0	0.0090	25
0.2	5.0	0.068	20
0.3	3.3	0.25	15
0.4	2.5	0.46	10
0.5	2.0	0.64	5
0.7	1.43	0.86	5
1.0	1.0	1.0	-
1.5	0.67	1.04	5
2.0	0.5	1.0	10
3.0	0.33	0.89	15
5.0	0.2	0.66	20

BB Vertical and Horizontal

f (cps)	T (sec)	R. M.	A. T. (±%)
0.04	25.0	0.104	20
0.06	16.7	0.350	20
0.08	12.5	0.775	15
0.1	10.0	0.950	10
0.2	5.0	1.0	5
0.4	2.5	1.0	5
0.8	1.25	1.0	-
1.6	0.625	1.0	5
3.2	0.312	1.0	10
6.4	0.156	0.980	15

KEY

R. M.	Relative magnification
A. T.	Amplitude tolerance
a	Tolerance not established in the period
b	Measurements not reliable due to interference from microseismic background noise
c	These norms and tolerances apply to the broad-response, long-period system (LP1).

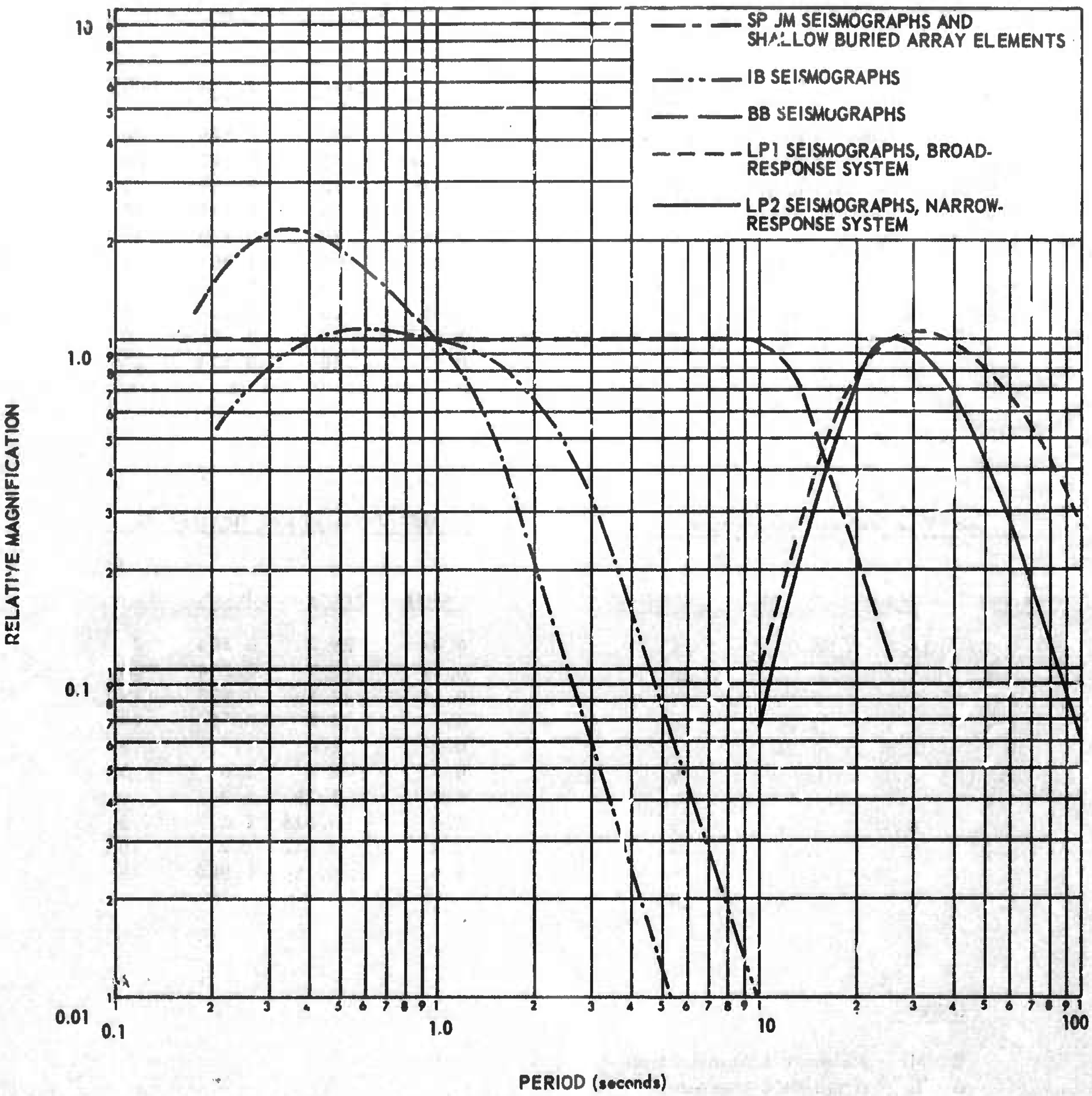

Figure 2. Normalized response characteristics of the standard seismographs at UBSO

Table 3. Data channel assignments and normal operating magnifications at UBSO

LEVELOCORDERS

FAST SPEED 30mm/min. (Data Groups 5044, 5064, 5076, 5072) — **SLOW SPEED 3mm/min.** (Data Group 5074)

Channel	DATA GROUP 5044 SP Primary Trace	5044 Mag.	DATA GROUP 5064 Trace	5064 Mag.	DATA GROUP 5076 Trace	5076 Mag.	DATA GROUP 5072 MAP II Trace	5072 Mag.	DATA GROUP 5074 Trace	5074 Mag.
1	V	20K	V	2K	SZ10L	60K	Test	---	WI	$\frac{3 \text{ mph/mm}}{S=0/8\text{ mm }(E=6)}$
2	SZ1	600K	MS1	0.75μb/mm	NSPL	60K	MCF11	Testing	SZ2	300K
3	SZ3	600K	MS2	0.75μb/mm	ESPL	60K	MCF12	Testing	ZLP1	25K
4	SZ5	600K	DH6	1000K	Z10LL	5K	MCF13	Testing	NLP1	25K
5	SZ2	600K	DH5	1000K	NSPLL	5K	MCF14	Testing	ELP1	25K
6	SZ4	600K	DH4	1000K	ESPLL	5K	MCF15	Testing	ZLP2	100K
7	SZ6	600K	DH3	1000K	SZ1	600K	MCF16	Testing	NLP2	100K
8	SZ7	600K	DH2	1000K	SZ3	600K	MCF17	Testing	ELP2	100K
9	SZ8	600K	DH1	1000K	SZ5	600K	BSSV1	Testing	ML1	3μb/mm
10	SZ9	600K	ΣDHF	6000K	ΣSSF	6000K	BSSV2	Testing	ML2	3μb/mm
11	ΣSSF	6000K	ΣDH	1500K	ΣSS	1500K	BSSV3	Testing	USO -	LP -
12	ΣSS	1500K	SZ8	600K	Z10	600K	BSSV4	Testing	ZBB	1.0K
13	SZ10	600K	USO-SP	---	NSP	600K	BSSV5	Testing	NBB	1.0K
14	NSP	600K	USO-Time	---	ESP	600K	BSSV6	Testing	EBB	1.0K
15	ESP	600K	W1	$\frac{3 \text{ mph/mm}}{S=0/8\text{ mm }(E=6)}$	TCDMG (Tape #1)	---	ΣDVS	Testing	WWV	
16	WWV	---	WWV	---	WWV	---	WWV	-----	---	

MAGNETIC TAPE RECORDERS

Channel	DATA GROUP 5029 No. 1 Trace	DATA GROUP 5023 No. 2 Trace	DATA GROUP 5025 No. 3 Trace	DATA GROUP 5035 No. 4 Trace
1	TCDMG	TCDMG	TCDMG	TCDMG
2	DH1	ZBB	SZ1	USOZSP
3	DH2	NBB	SZ2	USOZLP
4	DH3	EBB	SZ3	USO Time
5	DH4	NSP	SZ4	ΣSSF
6	DH5	ESP	SZ5	MCF11
7	Comp.	Comp.	Comp.	Comp.
8	DH6	ZLP1	SZ6	MCF12
9	ΣDH	NLP1	SZ7	MCF13
10	ΣDHF	ELP1	SZ8	
11	Z10LL	ZLP2	SZ9	
12	NSPLL	NLP2	SZ10	
13	ESPLL	ELP2	ΣSS	
14	WWV & Voice	WWV & Voice	WWV & Voice	WWV & Voice

Table 4. Key to the designations used in the data format assignments at UBSO

Z	Amplified vertical short-period seismograph from a surface site identified by a suffix number
SZ	Amplified vertical short-period seismograph from a shallow-buried site identified by a suffix number
NSP	Amplified north-south short-period seismograph
ESP	Amplified east-west short-period seismograph
V	Unamplified vertical short-period seismograph
ZLP1	Vertical long-period seismograph, broad response
NLP1	North-south long-period seismograph, broad response
ELP1	East-west long-period seismograph, broad response
ZLP2	Vertical long-period seismograph, narrow response
NLP2	North-south long-period seismograph, narrow response
ELP2	East-west long-period seismograph, narrow response
ZBB	Vertical broad-band seismograph
NBB	North-south broad-band seismograph
EBB	East-west broad-band seismograph
ΣS	Summation of Z1 through Z10
ΣSF	ΣS filtered
ΣSS	Summation of SZ1 through SZ10
ΣSSF	ΣSS filtered
DH1	Vertical-array element at 8895 feet
DH2	Vertical-array element at 7903 feet
DH3	Vertical-array element at 6910 feet
DH4	Vertical-array element at 5894 feet
DH5	Vertical-array element at 4901 feet
DH6	Vertical-array element at 3907 feet
ΣDH	Summation of DH1 through DH6
ΣDHF	ΣDH filtered
ML1	Long-period microbarograph (inside LP vault)
ML2	Long-period microbarograph (outside LP vault)
MS1	Short-period microbarograph (inside LP vault)
MS2	Short-period microbarograph (outside LP vault)
WI	Anemometer-wind speed and direction

Table 4, Continued

WWV	Radio time (WWV, STS, and voice on tape)
Test	Test instrumentation
Comp	Compensation
Mag	Magnification (see note)
TCDMG	Time code data management group
USO-SP	Unmanned seismological observatory short-period seismograph
USO-LP	Unmanned seismological observatory long-period seismograph
MCF1	Multichannel filter: ∞velocity signal and measured noise correlations (not including road noise) using Z1 - Z10
MCF3	Multichannel filter: 8.1 ∞km/sec velocity signal and measured noise correlations (not including road noise) using Z1 - Z10
MCF4	Multichannel filter: ∞velocity signal and measured noise correlations (including road noise), using Z1 - Z10
ΣSBS	Summation of Z1 - Z10, with MAP band-pass filter
BSS1	Beam-steered summation: 8.1 km/sec signal from azimuth of 0°, using Z1 - Z10
BSS2	Beam-steered summation: 8.1 km/sec signal from azimuth of 60°, using Z1 - Z10
BSS3	Beam-steered summation: 8.1 km/sec signal from azimuth of 120°, using Z1 - Z10
BSS4	Beam-steered summation: 8.1 km/sec signal from azimuth of 180°, using Z1 - Z10
BSS5	Beam-steered summation: 8.1 km/sec signal from azimuth of 240°, using Z1 - Z10
BSS6	Beam-steered summation: 8.1 km/sec signal from azimuth of 300°, using Z1 - Z10
MCF11	Multichannel filter: ∞velocity signal and measured noise correlations (not including road noise), using SZ1 - SZ10
MCF12	Multichannel filter: ∞velocity signal and theoretical noise model,using SZ1 - SZ10 and DH1 - DH6
MCF13	Multichannel filter: ∞velocity signal and theoretical noise model,using DH1 - DH6
MCF14	Deghost filter: up-going ∞velocity P-wave signal and theoretical noise model,using DH1, DH3, and DH5
MCF15	Deghost filter: down-going ∞velocity P-wave signal and theoretical noise model,using DH1, DH3, and DH5
MCF16	Deghost filter: up-going ∞velocity P-wave signal and theoretical noise model, using DH2, DH4, and DH6
MCF17	Deghost filter: down-going ∞velocity P-wave signal and theoretical noise model, using DH2, DH4, and DH6

Table 4, Continued

BSSV1	Beam-steered summation: up-going ∞velocity P-wave, using DH1 - DH6
BSSV2	Beam-steered summation: up-going 8.1 km/sec P-wave, using DH1 - DH6
BSSV3	Beam-steered summation: up-going 8.1 km/sec S-wave, using DH1 - DH6
BSSV4	Beam-steered summation: down-going ∞velocity P-wave, using DH1 - DH6
BSSV5	Beam-steered summation: down-going 8.1 km/sec P-wave, using DH1 - DH6
BSSV6	Beam-steered summation: down-going 8.1 km/sec S-wave, using DH1 - DH6
ΣDVS	Summation of SZ1 - SZ10 and DH1 - DH6, with MAP band-pass filter

NOTE
Magnification of:
Short-period measured at 1 cps
Broad-band measured at 0.8 cps
Long-period measured at 0.04 cps
MCF measured at 1 cps
BSS measured at 1 cps

2.4 COMMERCIAL POWER FAILURES

Failures of commercial power occurred on four occasions during July. On three of the occasions, the 15-ampere protection fuse in the Wanlass voltage regulator opened. No damage to the regulator occurred. On one occasion the power control switching relay failed when power returned, causing a loss of approximately 10 minutes of data, and on another occasion, the pinch roller on tape recorder No. 3 failed to close when power returned, causing the entire reel of tape to be wound onto the takeup spool.

2.5 SHIPMENT OF DATA TO THE SEISMIC DATA LABORATORY (SDL)

Magnetic-tape seismograms are shipped to SDL with the regular Long-Range Seismic Measurements (LRSM) Program data shipment about 15 days after the end of the month during which they were recorded. The seismograms from magnetic-tape recorders 1, 2, 3, and 4 recorded at UBSO through 30 June have been shipped to SDL.

All 16-millimeter film seismograms recorded at UBSO through 31 May were sent to SDL. More recent films are currently held in Garland for special studies.

2.6 QUALITY CONTROL

Quality control checks were made on randomly selected runs of all recordings from the observatory. Results of the checks were sent to the observatory for corrective action as necessary.

2.7 CHANGE IN STATION CALIBRATION TIME

In order to provide more efficient station operation, station calibration time was changed from 1500Z to 1900Z on 15 June. Change of 16-millimeter film continues to be made at 1430Z.

2.8 STABILITY OF CALIBRATORS IN THE UBSO SHALLOW-BURIED ARRAY SEISMOGRAPHS

To determine the stability of the weight-lift calibrators and the electromagnetic calibrators in the seismometers of the shallow-buried array seismographs, remote weight-lift tests were conducted on 2 May. A comparison was made between the equivalent weights determined from these data and equivalent weights determined on 4 May 1965. Table 5 shows the percent change in equivalent weights over this two-year period. The values of percent change in equivalent weights for all seismometers except SZ1 and SZ10 indicate stability of the calibrators. We plan to check the results obtained for SZ1 and SZ10 and, if necessary, remove the seismometers from the shallow holes and perform manual weight-lift determinations on them.

Table 5. Equivalent weight test data

Seismometer	Equivalent weight measured 4 May 65 (mg)	Equivalent weight measured 2 May 67 (mg)	Percent change
SZ1	41.6	39.9	-4.08
SZ2	42.3	42.2	-0.24
SZ3	Inoperative	44.5	+2.30[a]
SZ4	42.4	43.0	+1.42
SZ5	45.0	45.3	+0.67
SZ6	44.5	44.7	+0.45
SZ7	45.1	45.3	+0.44
SZ8	43.9	43.7	-0.46
SZ9	47.7	47.5	-0.42
SZ10	43.7	41.2	-5.71

[a]Percent change based on equivalent weight of 43.5 mg determined immediately after installation of shallow-buried array.

2.9 LIGHTNING STORM

A lightning storm on 22 June destroyed the phototube amplifier galvanometers of Z1 and Z3.

2.10 COOPERATION WITH THE LONG-RANGE SEISMIC MEASUREMENTS (LRSM) PROGRAM

With the approval of the Project Officer, UBSO personnel reported, by telephone, data on teleseisms recorded at UBSO from 2 May to 24 May to Mr. Rudi Weisbrich of the Geotech LRSM group for use in a study conducted by the LRSM group.

2.11 EQUIPMENT RECEIVED FROM CPSO

An Ampex magnetic-tape recorder, a microbarograph system, and miscellaneous components, transferred from CPSO, arrived at UBSO on 30 May. The Ampex magnetic-tape recorder and two miniature horizontal Benioff seismometers were shipped to our Garland laboratory on 27 June. The seismometers will be used as part of the short-period horizontal array at WMSO. After reconditioning, the Ampex magnetic-tape recorder will be used for quality control and special tests on observatory magnetic tapes in our Garland laboratory.

2.12 COMMERCIAL SEISMIC EXPLORATION IN UBSO ARRAY AREA

On 17 July, it was discovered that a Digital Consultants, Inc., seismic exploration crew was planning to shoot two profiles across the UBSO array. The following day, UBSO personnel denied the exploration crew access to the UBSO array area, pending approval of the exploration operation by the Project Officer. After consultation among the Project Officer, the Program Manager, and Tennessee Oil Company personnel, permission was granted Digital Consultants, Inc., to conduct the survey in the array area. Drilling and road building operations associated with the seismic survey caused the UBSO seismograms to be extremely noisy from 19 July until the shooting began on 23 July. During the shooting operations on 23, 24, and 25 July, the primary seismographs were attenuated 36 dB for a total of approximately 30 hours.

3. EVALUATE DATA AND PROVIDE MOST EFFECTIVE OBSERVATORY POSSIBLE

3.1 MODIFICATIONS TO INSTRUMENTATION AT UBSO

On 6 May, a modified strobe unit was installed in the Timing System, Model 11880. The modified strobe unit improved the performance of the timing system to some degree; however, the 1 kW Power Amplifier, Model 22183, occasionally dropped out during adjustments of the timing system during this reporting period.

Because of an apparent change in the characteristics of the quartz crystal of the frequency standard of the timing system, the crystal oscillator tuning capacitor was changed on 31 July to provide an adequate range of adjustment for the timing system.

3.2 ADDITIONS TO INSTRUMENTATION AT UBSO

3.2.1 Paper-Tape Punching Machine for Preparing Routine Messages

Arrangements were completed with the General Services Administration, Denver, in May for UBSO to acquire a surplus Model 19 teletypewriter set for use in preparing routine messages to the Coast and Geodetic Survey (C&GS). The teletypewriter set arrived at UBSO on 26 June; however, a printer-perforator unit was not included. Using a printer-perforator borrowed from the UBSO station engineer, UBSO personnel began taping C&GS messages for Western Union's Vernal office on 28 June. However, there have been minor malfunctions of both the teletypewriter and the Western Union paper-tape reading equipment throughout the reporting period.

3.2.2 Calibration of Attenuators for Low-Gain Seismographs

The special T-pad attenuators constructed by UBSO personnel to provide gains below the range of the PTA attenuators were calibrated during the reporting interval. The attenuation values are listed in table 6.

Table 6. Attenuation values of special attenuators for low-gain seismographs

Attenuator number	Attenuator dB
JM1	60.36
JM2	60.92
JM3	60.36
JM4	60.72
JM5	60.63
JM6	60.51
JM7	60.36
18300-1	61.72
18300-2	61.01
18300-3	60.36
18300-4	60.36
18300-5	60.72

3.2.3 Hole for Long-Period Triaxial Seismometer

Drilling of the hole under Project VT/6706 for the long-period triaxial seismometer was begun on 31 July. At the end of the reporting period, a 4-3/4 inch pilot hole had been drilled to a depth of 80 feet.

4. TRANSMIT DAILY MESSAGES TO THE COAST AND GEODETIC SURVEY

The arrival time, period, and amplitude measurements for events recorded at UBSO were reported daily to the Director of the Coast and Geodetic Survey in Washington, D.C. The number of events, by type, reported by UBSO during each month in this reporting period is shown in table 7. The total number of events recorded by the observatory, the number of epicenters determined by the C&GS and reported in the "Earthquake Data Report," the percent of the C&GS hypocenters for which the C&GS report listed a UBSO P or PKP arrival, the percent of C&GS hypocenters for which UBSO recorded a P or PKP phase, as determined from associated data, and the percent of C&GS hypocenters for which UBSO recorded a P, PKP, or later phase, based on updated associated data, are given in table 8 for January, February, and March 1967. Lists of more recent epicenters have not been completed by the C&GS.

In the past, we have reported the percent of the C&GS hypocenters for which the C&GS report listed a UBSO P or PKP arrival as "percent of C&GS events utilizing UBSO data." The percentages reported were not accurate, because the C&GS does not use PKP arrivals in their hypocenter location routine. In the future, we will compute the percent of C&GS hypocenters utilizing UBSO data on the basis of those hypocenters less than 100 degrees from the observatory.

Table 7. Number of earthquakes reported to the C&GS during May, June, and July 1967

	Local	Near regional	Regional	Teleseismic	Total
May	48	434	59	1118	1659
June	19	371	39	1249	1678
July	27	246	24	1145	1442

5. PUBLISH MONTHLY EARTHQUAKE BULLETIN

5.1 BULLETIN STATUS

Data from UBSO were combined with data from BMSO, CPSO, TFSO, and WMSO and published in a multistation earthquake bulletin. The bulletins for January, February, and March 1967 were published and distributed during the reporting period. Raw data for April, May, and June were keypunched, transcribed onto magnetic tape, and sent to SDL for association. Keypunching of the July raw data was about 40 percent complete at the end of the reporting period.

Table 8. Percentage of hypocenters reported in the C&GS "Earthquake Data Report" for which UBSO data were used

Month	No. events reported by UBSO	No. C&GS hypocenters	Percent of C&GS hypocenters for which the C&GS listed a UBSO P or PKP arrival	Percent of C&GS hypocenters for which UBSO recorded a P or PKP phase, based on associated data	Percent of C&GS hypocenters for which UBSO recorded a P, PKP, or later phase, based on updated assocoated data
January	1990	494	64.6	67.2	73.9
February	1565	301	72.1	74.1	79.7
March	1748	411	69.6	71.1	79.2

5.2 REVISED BULLETIN DISTRIBUTION LIST

A revised distribution list for the five-station earthquake bulletin, based on the results of our bulletin-use survey, was submitted to the Project Officer on 26 May. Distribution of the bulletin was made according to the revised list beginning with the February 1967 bulletin.

6. MAINTAIN UBSO FACILITIES

6.1 AIR-CONDITIONING SYSTEM

The air-conditioning system became inoperative on 5 May. The trouble was traced to a control wire whose insulation had been damaged by vibration in the motor starter box. The wire was replaced and the unit returned to operation.

With the approval of the Project Officer, modifications to the air-conditioning system to assure reliable operation of the observatory were made in late May. The work was done by Automatic Systems Co., Provo, Utah.

6.2 KITCHEN SINK DRAIN PIT

In order to prevent clogging of the kitchen sink, the drain pit was enlarged and 8 cubic yards of fresh drain-field rock were placed in the pit in May.

7. MAINTAIN UBSO EQUIPMENT

7.1 FLOODING OF DEVELOCORDERS

Develocorder floods, due to slime formation, continued to occur during the reporting period. Various methods of applying algacides to the Develocorder water supplies were tried, with only partial success. A flood in Develocorder [illegible] on 29 July shorted the take-up switch and burned all the wiring in the Develocorder. All optical components were cleaned and the Develocorder was completely rewired.

We are continuing to study possible means of controlling slime formation in the Develocorder water supplies.

7.2 NEW VOLTAGE REGULATOR

To increase the capability and reliability of the power subsystem, a new Voltage Regulator, Wanlass Model RFI [illegible], was installed on 8 June, replacing the S&E voltage regulator. The new regulator has operated satisfactorily since its installation.

7.3 AMPEX TAPE RECORDER (MAGNETIC-TAPE RECORDER 4)

A new pinch roller was installed in the Ampex magnetic-tape recorder on 2 May. The new pinch roller eliminated all noticeable buckling of the tape.

7.4 MAGNETIC-TAPE RECORDERS 1 AND 2

On 22 May, a new set of record and playback heads were installed in magnetic-tape recorder 1. The old heads were sent to our Garland laboratory for repair and refinishing.

As part of the evaluation of the Geotech record and playback heads, the Minneapolis-Honeywell heads from magnetic tape recorder 1 were interchanged with the Geotech heads from magnetic-tape recorder 2 on 3 July. New tape was used on tape recorder 2 from 27 July through 31 July to determine the effect of the tape on signal-to-noise ratio. The results of this test were inconclusive. We plan to use new tape on tape recorder 1 for a similar length of time.

7.5 CALIBRATION OF STATION FUNCTION GENERATOR

A replacement function generator was sent from our Garland laboratory to UBSO and the station function generator was sent to our Garland laboratory in July for routine calibration.

8. INSTRUMENT EVALUATION

8.1 EVALUATION OF VERTICAL ARRAY

8.1.1 Malfunctions

On 28 May, malfunctioning of the fourth deepest element of the vertical array (DH4) was traced to a short in the line to the phototube amplifier (PTA) and a defective PTA galvanometer. While DH4 was being repaired, the deepest element of the vertical array (DH1) became inoperative. It was found that the mass position motor would not operate.

8.1.2 Overhaul of the Vertical Array

On 13 June, tests preparatory to removing the elements of the vertical array from the deep hole were begun. By 18 June, all six elements of the vertical array had been pulled. The following conditions were found in the indicated seismometers:

DH1 - Water, which apparently had entered through the holelock, was found in the seismometer. The holelock would not operate.

DH2 - Loose screws were found in the magnetic assembly. The upper data coil was loose, causing friction. The holelock would not operate.

DH3 - There was apparent mechanical damping in the seismometer.

DH4 - The holelock cam could not be retracted.

DH5 - The holelock cam could not be retracted.

DH6 - The holelock cam could not be retracted.

The seismometers were repaired, beginning on 21 June. By 5 July, the three deepest elements of the vertical array had been installed in the deep hole. On 6 July, it was discovered that the mass-position motor in DH2 would not operate. Inspection of the cable revealed that the conductor insulation was almost completely rotted, resulting in excessive leakage to ground. On 11 July, according to instructions of the Project Officer, we suspended work on installation of the vertical array until a new cable can be obtained from another project. Repair of the other three seismometers was completed by 12 July. As of the end of the reporting period, we were awaiting receipt of a suitable cable before proceeding with reinstallation of the vertical array.

8.1.3 Characteristics of Noise Recorded by the Vertical Array

Estimates of power spectral density of a 4-minute noise sample recorded by each element of the vertical array (DH1 through DH6) are presented in figures 3 through 8. Frequency responses of an element of the shallow-buried array (SZ1) and the shallowest element of the vertical array (DH6 at 3907 feet) are shown in figure 9. Note the greater response of the deep-hole instrument in the frequency band 1-3 cps. In figure 10 are shown the power spectral density estimates of the noise sample as recorded by SZ1 and as recorded by DH6, with the DH6 frequency response corrected to the frequency response of SZ1.

From these data we draw the following conclusions:

a. For the entire frequency band, most of the attenuation of noise power due to depth occurs between the surface and the shallowest element of the vertical array (DH6) at a depth of 3907 feet.

b. In the frequency bands 0.1 to 0.25 cps and 1.0 to 1.67 cps, there was little or no additional attenuation of noise power for depths greater than 3907 feet.

c. In the frequency band 0.25 to 0.5 cps, increasing depth beyond 3907 feet resulted in a maximum attenuation of 7 to 8 dB relative to DH6.

d. In the frequency band of 0.5 to 1.0 cps, DH6 recorded the lowest noise power of all the deep-hole instruments, and DH1 recorded the highest power. The maximum difference between the two instruments occurred at a frequency of 0.85 cps, where DH6 recorded about 7 dB less noise power than did DH1.

e. For the frequency band 1.67 to 3.33 cps, the maximum attenuation of noise power due to depths greater than 3907 feet was 5 to 6 dB relative to DH6.

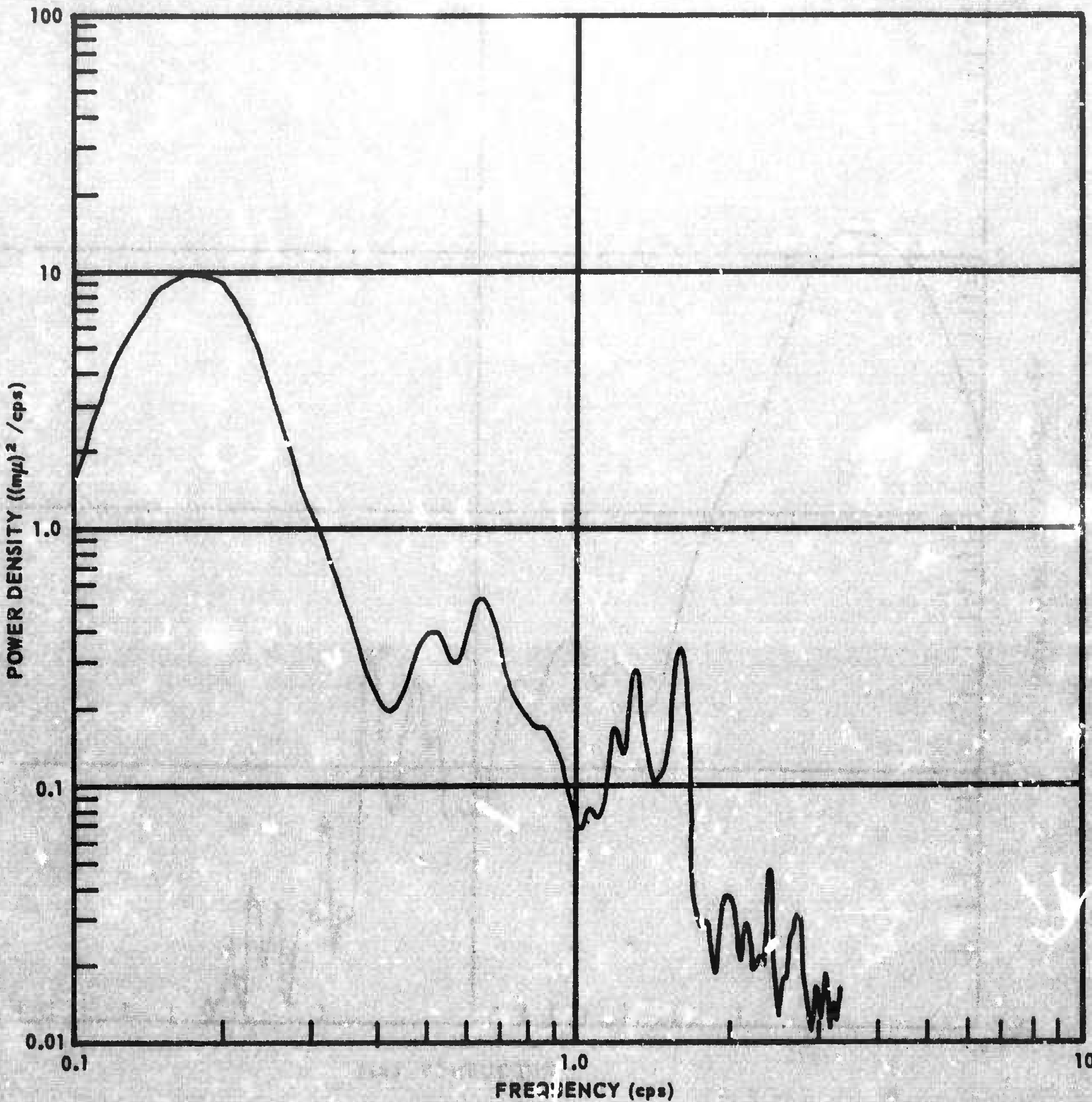

Figure 3. Power spectral density of 4-minute noise sample recorded by DH1 (depth = 8895 feet)

G 2985

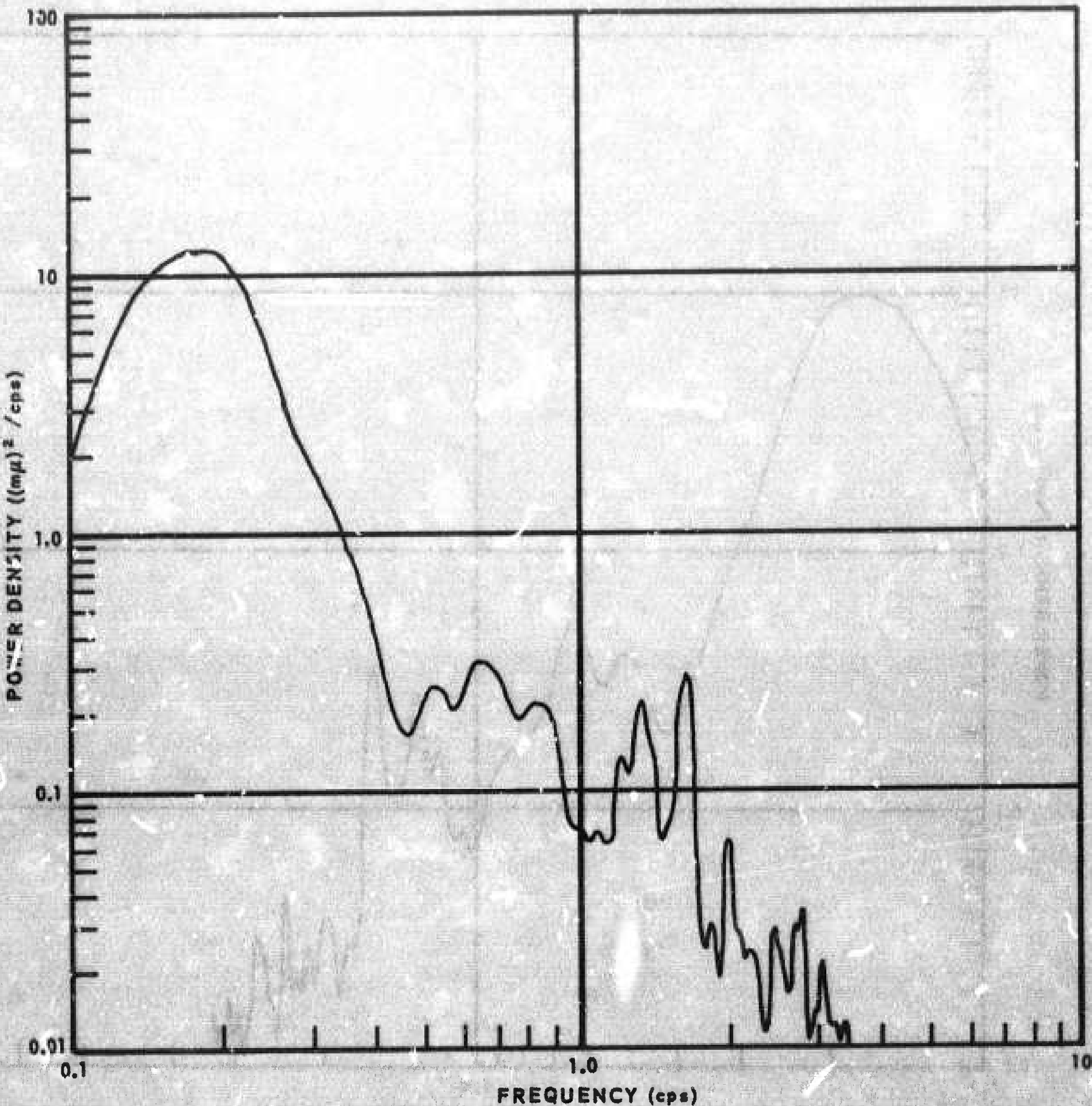

Figure 4. Power spectral density of 4-minute noise sample recorded by DH2 (depth = 7903 feet)

G 2986

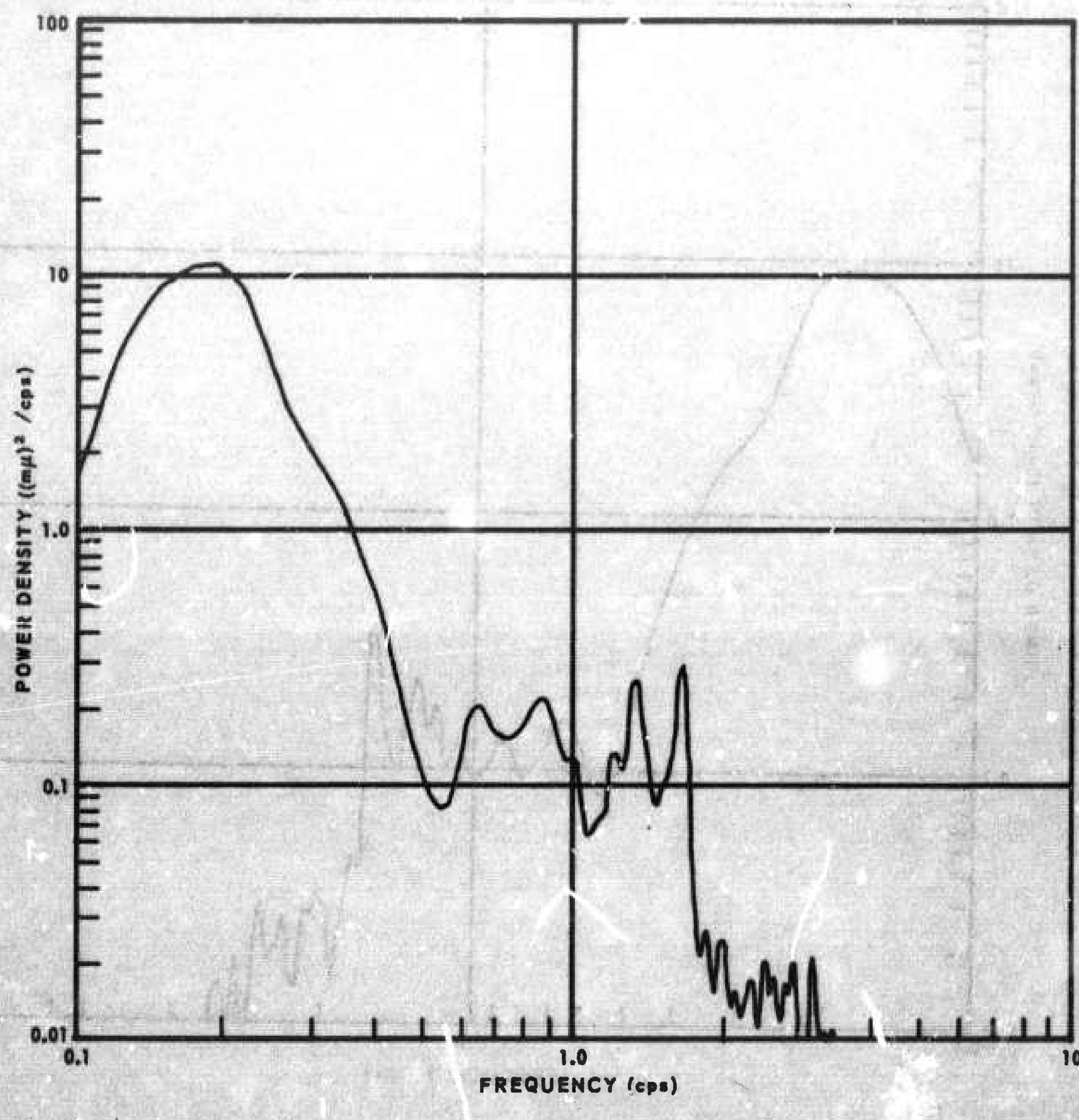

Figure 5. Power spectral density of 4-minute noise sample recorded by DH3 (depth = 6910 feet)

G 2987

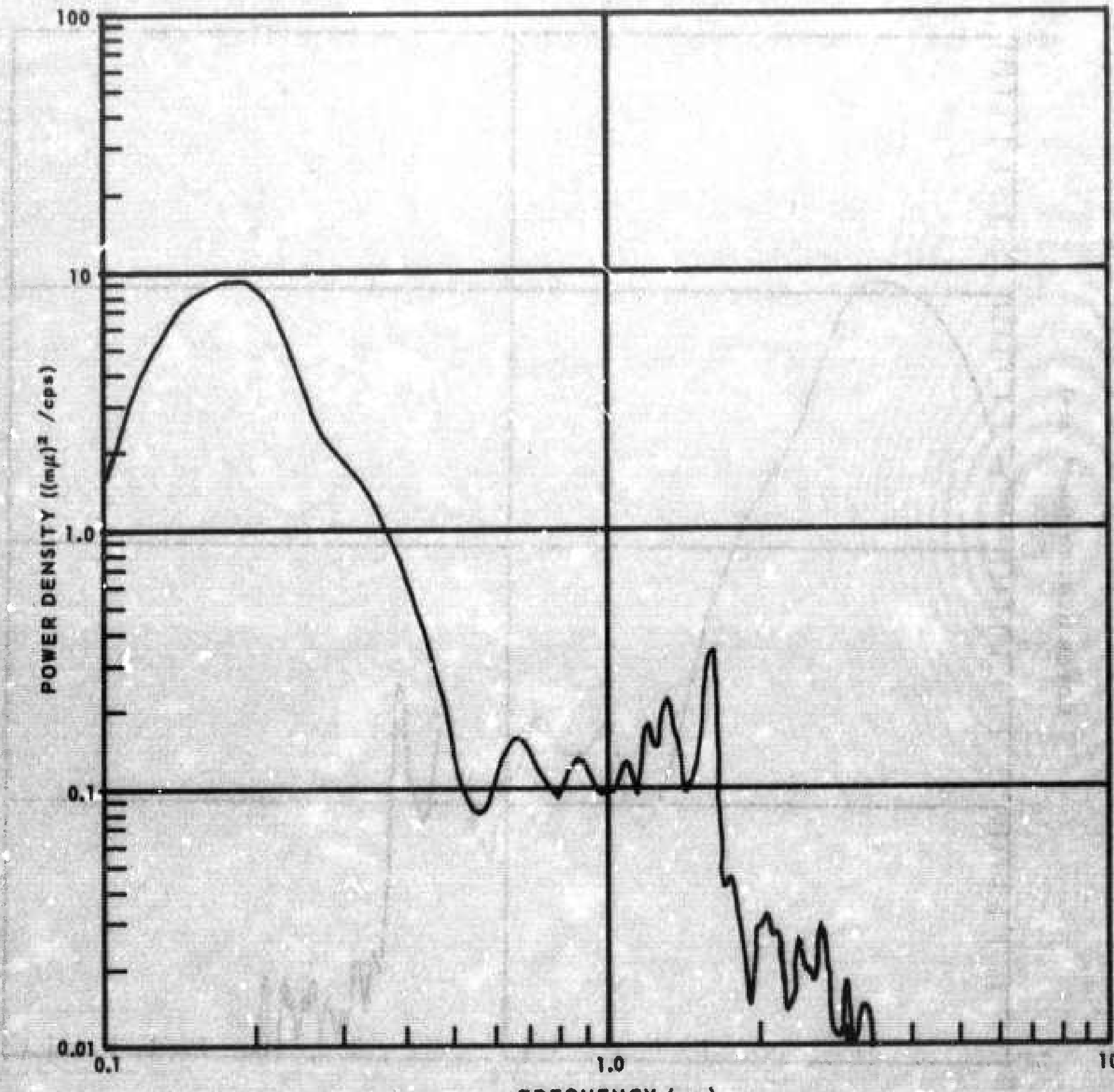

Figure 6. Power spectral density of 4-minute noise sample recorded by DH4 (depth = 5894 feet)

G 2988

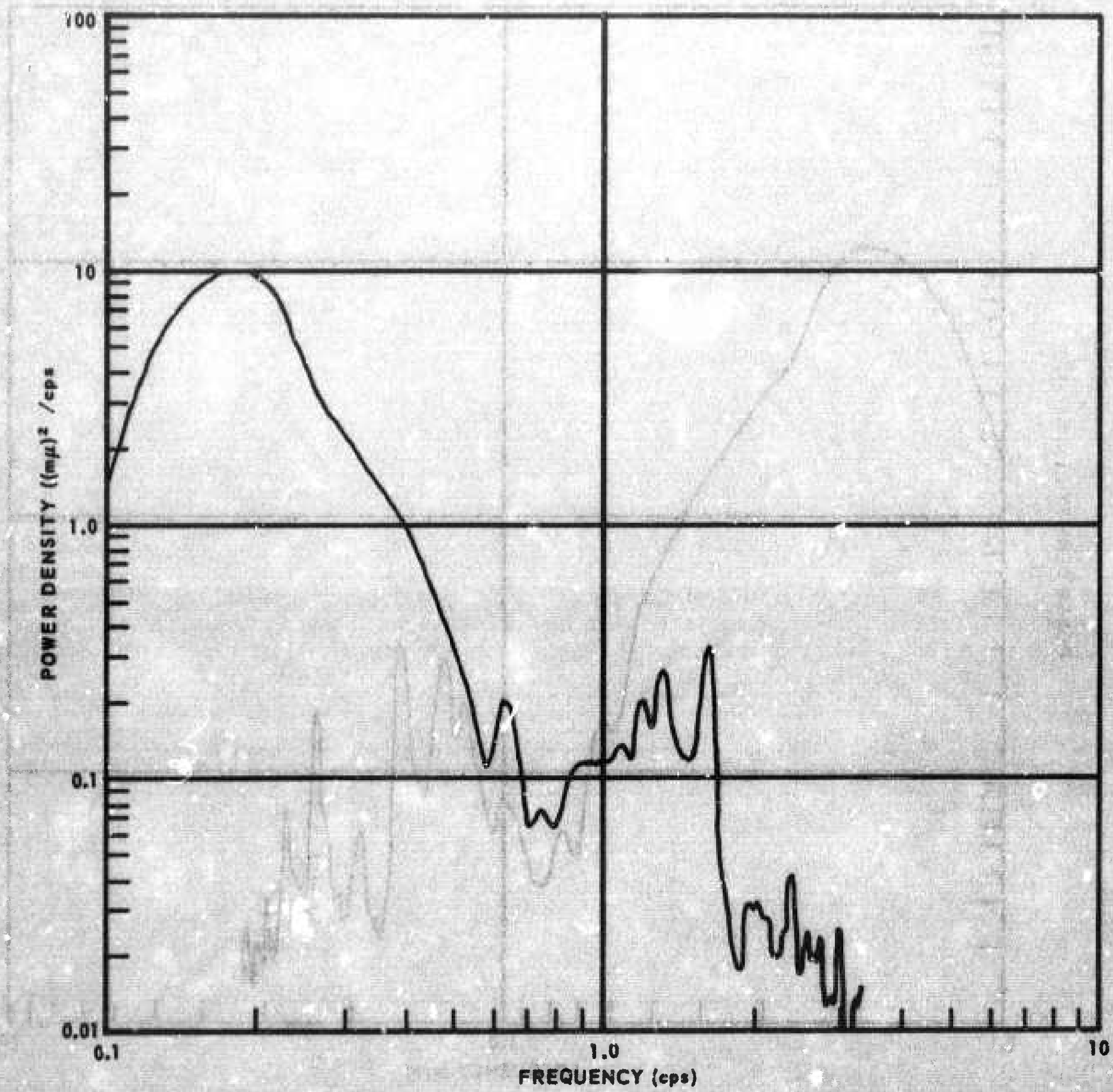

Figure 7. Power spectral density of 4-minute noise sample recorded by DH5 (depth = 4901 feet)

G 2989

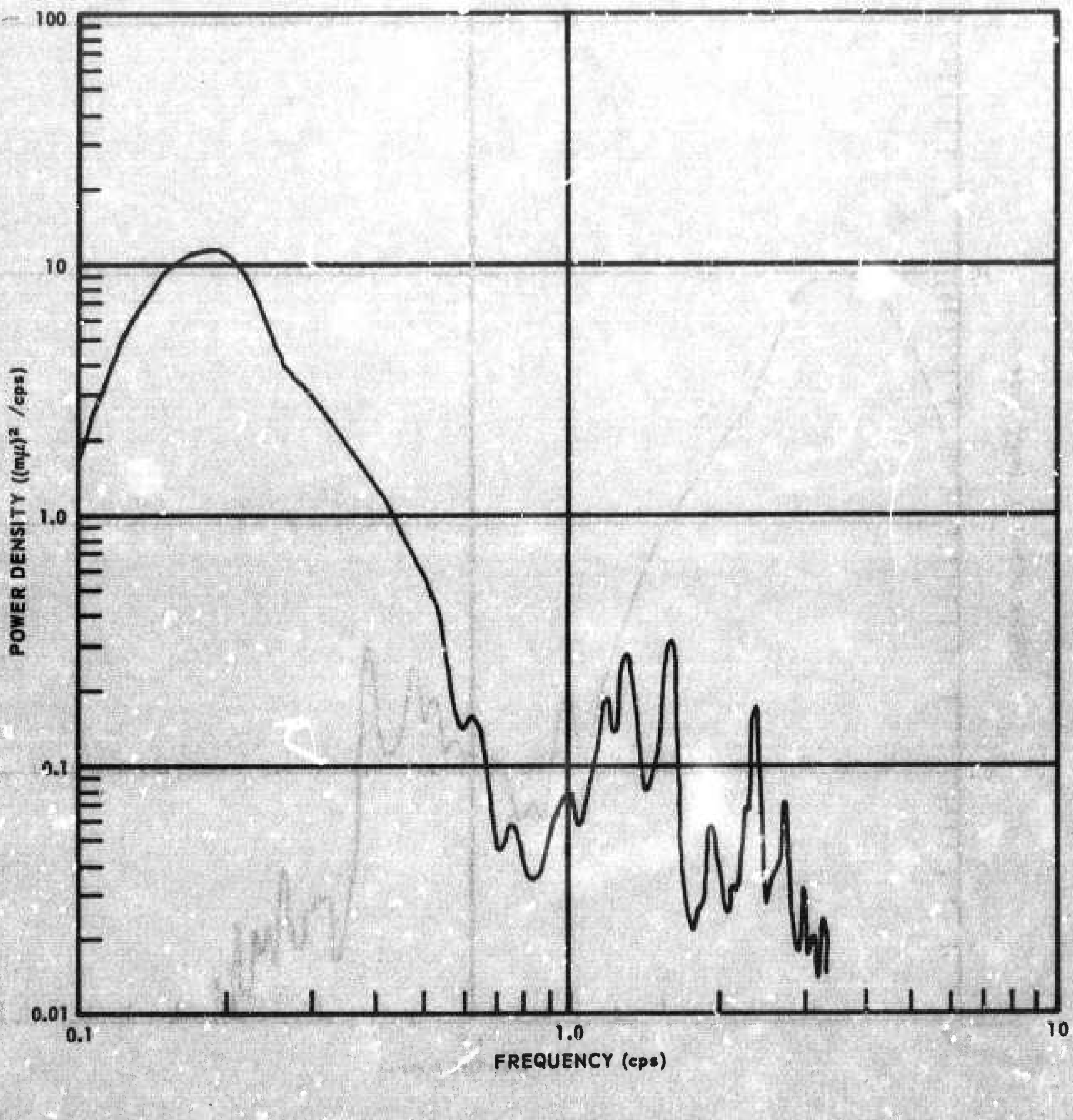

Figure 8. Power spectral density of 4-minute noise sample recorded by DH6 (depth = 3907 feet)

G 2990

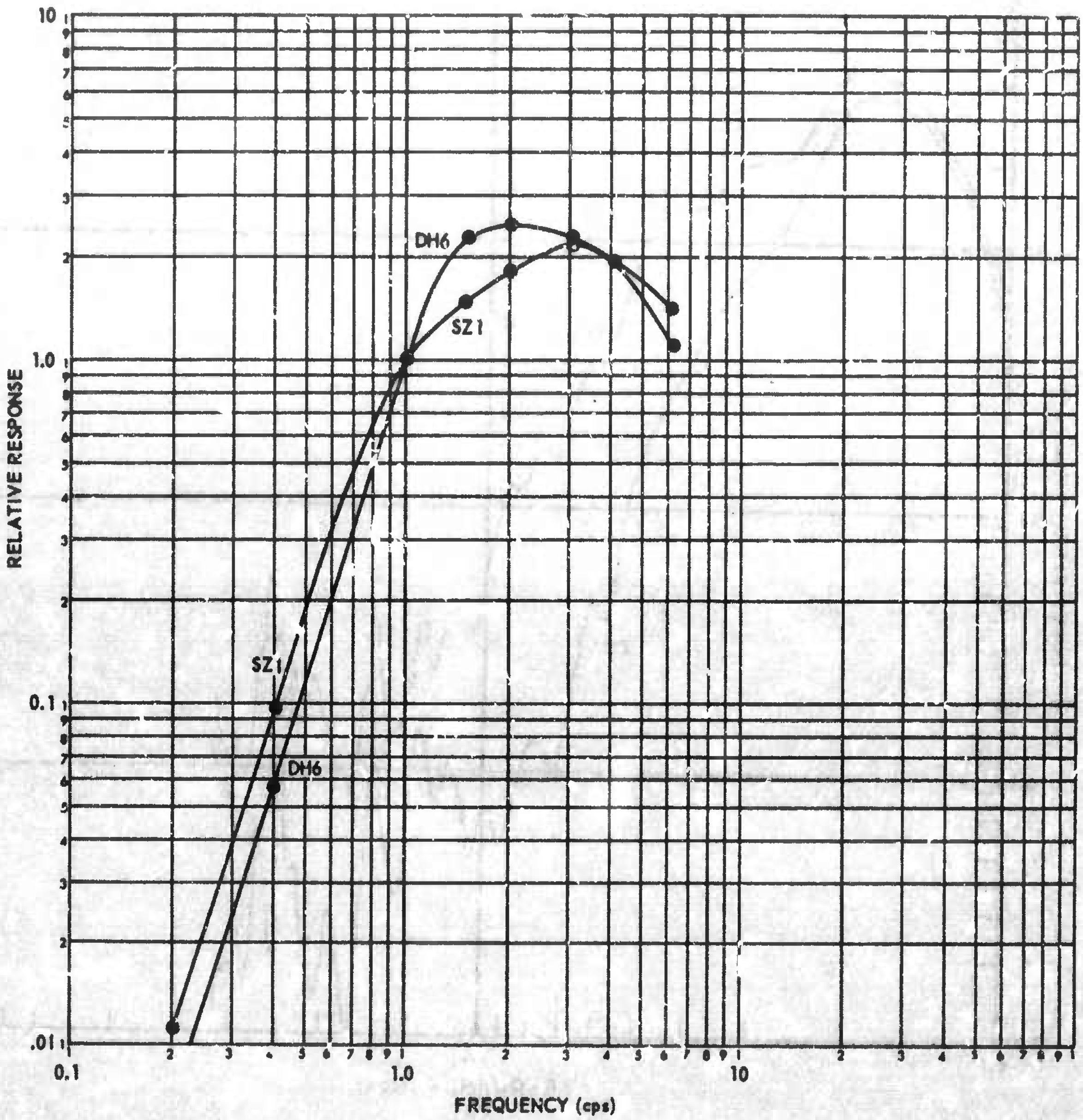

Figure 9. Normalized frequency responses of an element of the shallow-buried array (SZ1) and an element of the vertical array (DH6)

G 2991

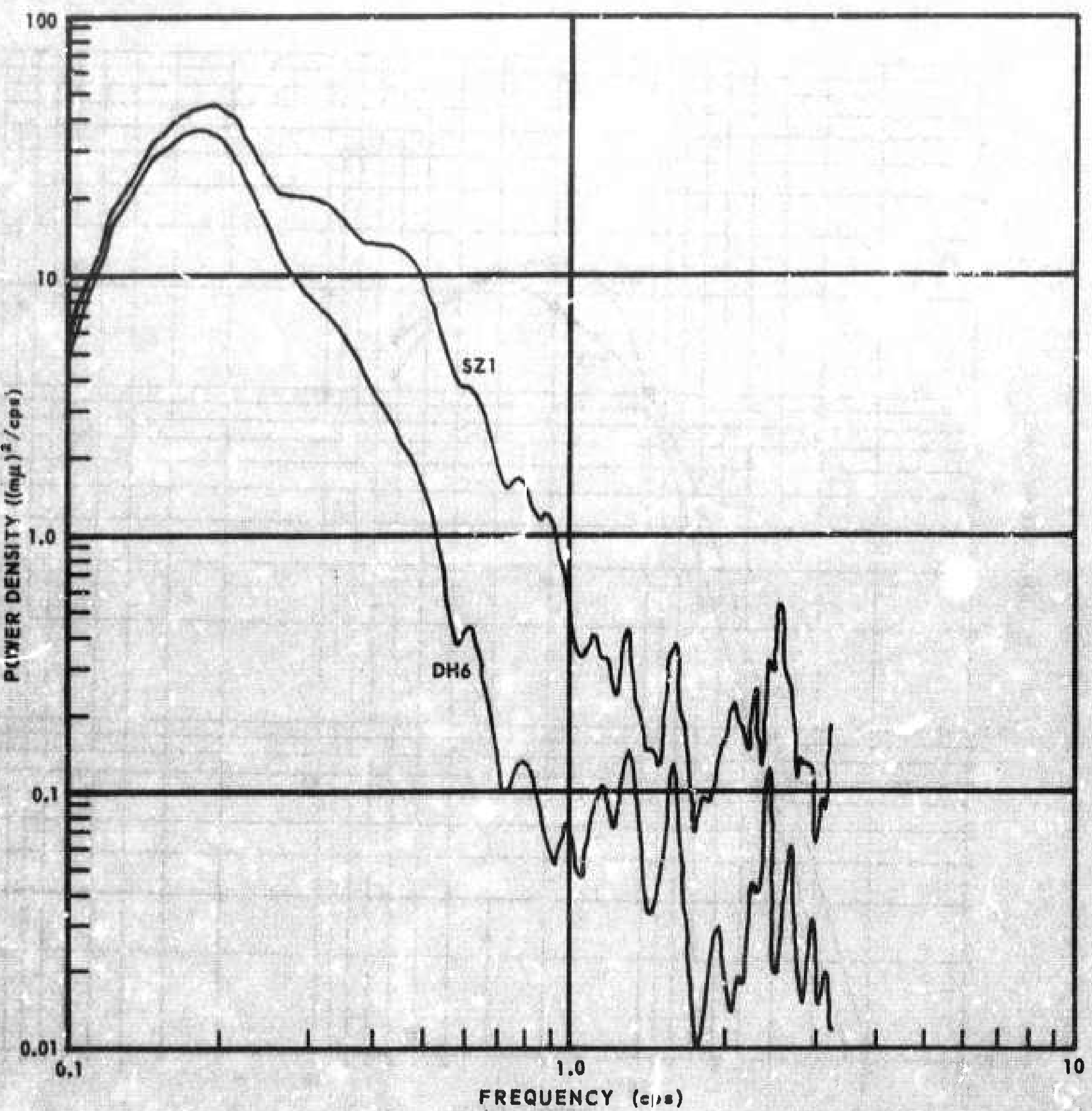

Figure 10. Power spectral density of 4-minute noise sample recorded by SZ1 and DH6, with frequency response of DH6 corrected to frequency response of SZ1

The main conclusion is that, in the frequency band in which most power normally occurs in typical P-wave signals (0.67 to 2.0 cps), DH6, at a depth of 3907 feet, recorded less noise power than any deeper element of the vertical array. However, previous studies (The Geotechnical Corp., 1964, Shappee and Douze, 1967) indicate that, because of attenuation of signal amplitude with increasing depth, the maximum S/N should occur in the depth range 4500 feet to 5100 feet.

After reinstallation of the vertical array, we plan to analyze another noise sample recorded by the vertical array and to study the attenuation of signal amplitude with increasing depth. Our study of signal characteristics will be based both on spectral characteristics of the signals as a function of depth and on visual measurements of the amplitudes of the first half cycle of the signals as a function of depth.

8.2 EVALUATION OF UNDERGROUND LONG-PERIOD VAULT

The new, advanced long-period seismometers arrived at UBSO on 10 May. Tests and adjustments of the new seismometers were completed on 7 June. Calibrator motor constants of the new, advanced long-period seismometers before and after adjustment are given in table 9.

Table 9. Calibrator motor constants (G's) of the new, advanced long-period seismometers before and after adjustment

New seismometer	G (newtons/ampere) before adjustment	G (newtons/ampere) after adjustment
ZLP bottom coil	0.0286	0.0286
top coil	0.0287	0.0284
NLP left coil	0.0274	0.0274
right coil	0.0279	0.0279
ELP left coil	0.0272	0.0284
right coil	0.0266	0.0284

Routine calibrations will be made using the bottom coil of the vertical and the left coils of the horizontal seismometers. The measured G's, after adjustment, are all within 3 percent of the nominal value of 0.0280 newtons/ampere. The new seismometers were installed in the 50-foot vault, beginning on 14 June. The lower chamber of the 50-foot long-period vault was sealed on 28 June. A time constant of 16.1 hours, based on a 3-hour test interval, was determined for the vault. Because of an uncertainty as to the polarity of the horizontal seismometers, the vault was reopened and the polarities were checked. The chamber was resealed and a time constant of 4.7 hours was determined. At the

end of the reporting period, the long-period seismometers were quiet enough to operate at standard magnifications; however, drifting and occasional spikes were still occurring.

8.3 TECHNICAL ASSISTANCE AND MONITOR OF SANDIA'S USO

Monitoring of the Sandia USO continued throughout the reporting period. Sandia personnel were at UBSO on 2 and 3 May, troubleshooting the USO. After extensive testing, a loose connection was found on the Sandia line from the output amplifier to the junction box. The USO has operated normally since the loose connection was repaired.

Sandia personnel were at UBSO on 28 June for a routine magnetic-tape change; while at the observatory, they also replaced the USO magnetic-tape recorder.

The USO system is normally checked for only a few minutes a day to determine that it is operational. On 19 July, USO-ZLP was recorded on a Helicorder all night to check the system over a longer period of time. This test revealed a 60-second periodicity in the recorded background. Sandia was notified of these results. Sandia personnel determined that the trouble is due to a power drain when the USO time-code generator cycles every 60 seconds. Sandia personnel plan to visit UBSO during the week of 14 August to modify the system.

9. SPECIAL INVESTIGATIONS

9.1 EVALUATION OF MULTIPLE ARRAY PROCESSORS

9.1.1 Termination of Operation of MAP I and Suspension of Operation of MAP II

With the approval of the Project Officer, operation of the MAP II systems was suspended on 31 May, pending overhaul of the vertical array, and operation of the surface array and MAP I was discontinued on 1 July. The surface array is not needed because primary data are taken from the shallow-buried array. Sufficient data have been recorded by the MAP I systems to complete the MAP evaluation.

9.1.2 Visual Signal-to-Noise Ratio Comparison

A comparison of signal-to-noise ratio (S/N), based on visual measurements of signal and noise amplitudes and periods, has been made for 10 MAP systems together with individual seismograms SZ10 and the filtered shallow-buried array summation (ΣSSF) for approximately 100 signals.

For each signal, the peak-to-peak amplitude and its associated period were measured from the film seismograms recorded by each system. The peak-to-peak amplitude and its associated half-period of each half cycle of the noise in the 10-second interval immediately preceding the signal onset were also

measured for each system. From these noise measurements, the average noise amplitude in the period range within ±0.3 second of the signal period was computed for each system. The S/N for each system was then computed as the ratio of signal amplitude to average noise amplitude for the given system.

Cumulative frequency distributions of S/N for MCF4, MCF1, MCF3, and MAP filtered surface array summation (ΣSBS) of MAP I and SZ10 and ΣSSF are presented in figure 11, and for MCF11, MCF12, MCF13, MCF14, MCF16, and Beam-Steered Vertical Array Summation I (BSSV1) of MAP II are presented in figure 12. The average S/N for each system $\left(\overline{(S/N)}_{Sys}\right)$ relative to the average S/N for ΣSBS $\left(\overline{(S/N)}_{\Sigma SBS}\right)$ is given in table 10. For each system, the percent of events with S/N greater than, equal to, and less than the S/N recorded by ΣSBS are listed in table 11. The ΣSBS was used as the reference system because it is a simple summation with the frequency filtering used in all of the MAP systems. Therefore, any improvement in noise rejection or signal enhancement due to multichannel filtering over that achieved by summation and frequency filtering should appear as an increase in S/N over the S/N observed on ΣSBS.

The only systems which show a significantly greater average S/N than ΣSBS are ΣSSF, MCF11, and BSSV1. The superiority of ΣSSF over ΣSBS is attributed to the narrower pass band of the frequency filter of ΣSSF and to the fact that ΣSSF operates on the elements of the shallow-buried array, whereas ΣSBS operates on elements of the surface array. The superior performance of MCF11 over that of ΣSBS is attributed to the fact that MCF11 operates on elements of the shallow-buried array rather than to the fact that MCF11 is a multichannel filter whose design is based on measured noise correlations. The multichannel filters designed from measured noise correlations which operate on elements of the surface array (MCF1, MCF3, and MCF4) all proved to be inferior to the straight summation operating on the same elements (ΣSBS). The only MAP system using elements of the vertical array which proved to appreciably superior to ΣSBS in the S/N study was BSSV1, which is a simple beam-steered system using all six elements of the vertical array, with time delays to enhance vertically incident P-waves. BSSV1 was superior to both MCF14 and MCF16, each of which is a deghosting filter operating on 3 elements of the vertical array, and was much superior to MCF13, which is a multichannel filter operating on all 6 elements of the vertical array, designed from a theoretical noise model.

9.1.3 Visual Noise Measurements

Visual noise measurements have been made for 10 MAP systems, using the sampling and measuring techniques that are used for the routine noise measurements from the standard UBSO seismograms. The measurements cover the period 1 January through 12 March 1967. Cumulative frequency distributions of trace amplitude, normalized to a gain of 1000K at 1 cps, are presented in figures 13 and 14 for the MAP I and MAP II systems, respectively. Figure 13 includes distributions for SZ10 and ΣSSF covering the same period of time. Table 12 lists, for each system, the average trace amplitude, normalized to a gain of 1000K at 1 cps, over the period band 0.4 second to 1.4 seconds, computed from the visual noise measurements.

The results of the visual noise measurements on the MAP systems are consistent with the results of the S/N study.

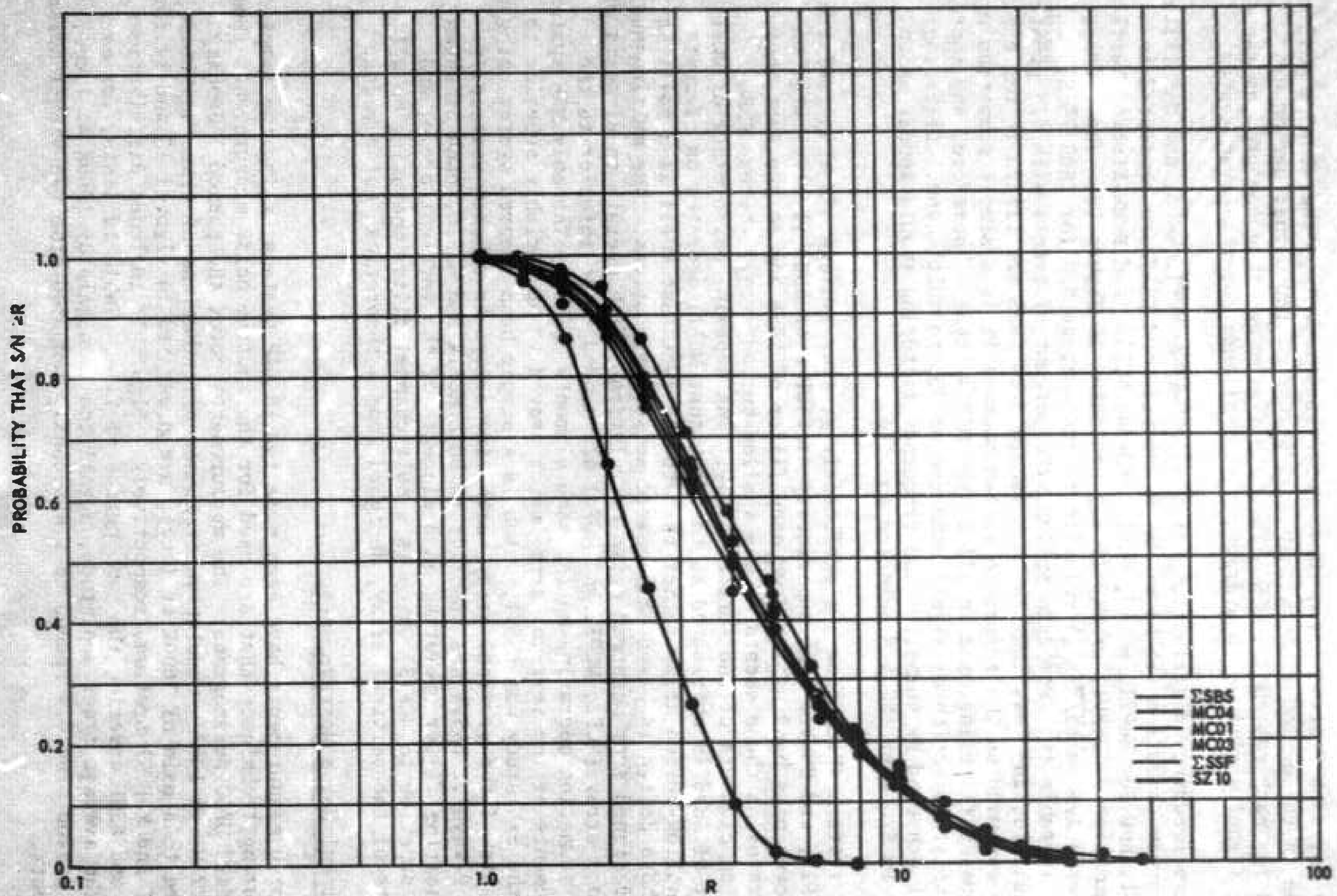

Figure 11. Cumulative frequency distributions of S/N for MAP I and Primary systems

G 2993

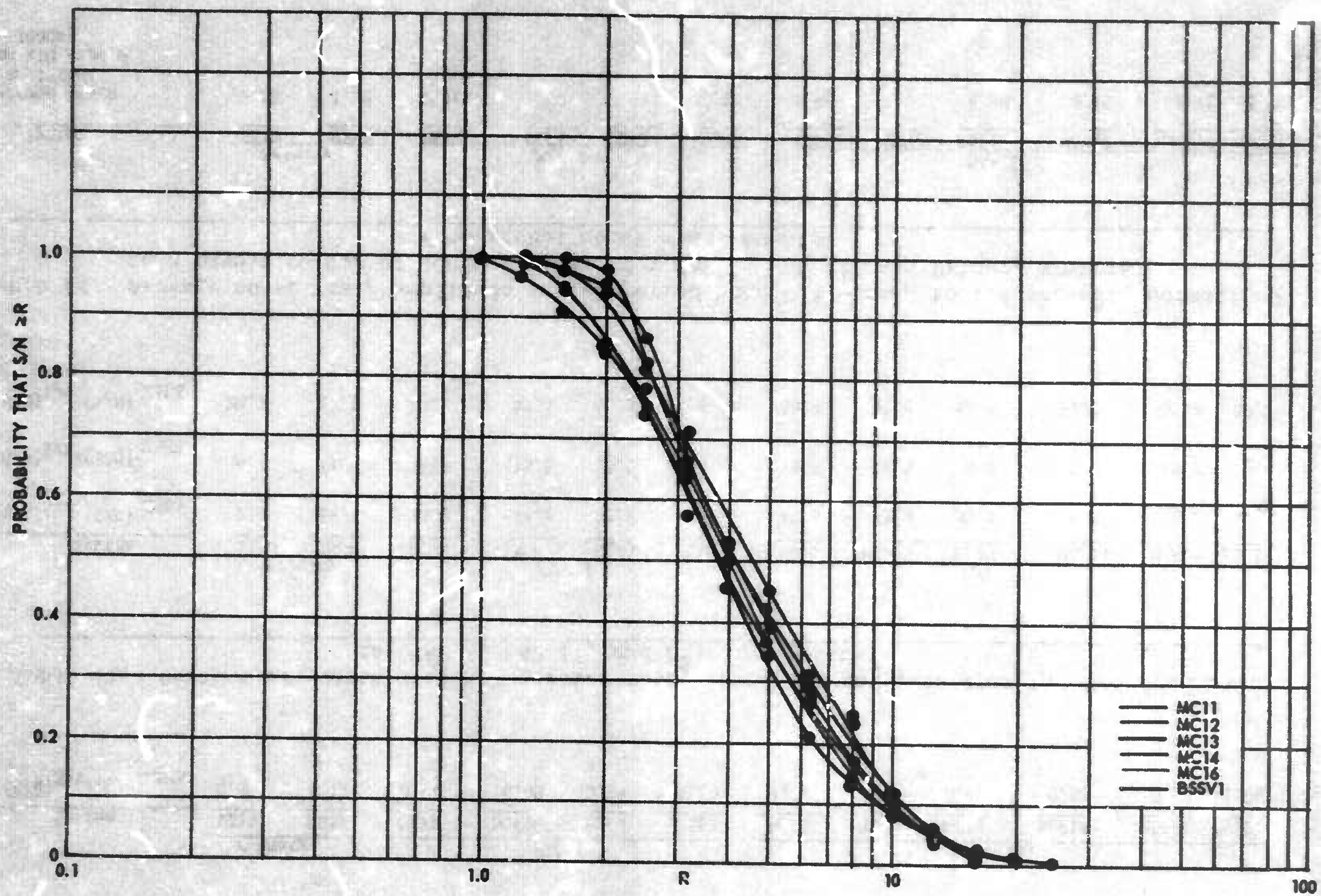

Figure 12. Cumulative frequency distributions of S/N for MAP II systems

G 2994

Table 10. Average S/N for each system $\left(\overline{(S/N)}_{Sys}\right)$ relative to average S/N for ΣSBS $\left(\overline{(S/N)}_{\Sigma SRS}\right)$, for MAP I, MAP II, and Primary systems

System	Primary		MAP I				MAP II					
	SZ10	ΣSSF	MCF4	MCF1	MCF3	ΣSBS	MCF11	MCF12	MCF13	MCF14	MCF16	BSSV1
$\overline{(S/N)}_{Sys}/\overline{(S/N)}_{\Sigma SBS}$	0.55	1.11	0.94	0.98	0.99	1.00	1.06	1.01	0.87	0.92	0.94	1.06

Table 11. Percent of events with S/N greater than, equal to, and less than the S/N for ΣSBS, for MAP I, MAP II, and Primary systems

System	Primary		MAP I				MAP II					
	SZ10	ΣSSF	MCF4	MCF1	MCF3	ΣSBS	MCF11	MCF12	MCF13	MCF14	MCF16	BSSV1
$\%(S/N)_{Sys}>(S/N)_{\Sigma SBS}$	7.2	58.3	38.2	41.2	36.2	0	49.5	47.9	35.4	39.4	36.4	47.9
$\%(S/N)_{Sys}=(S/N)_{\Sigma SBS}$	4.1	14.6	14.4	15.5	17.0	100.0	19.6	13.3	8.3	7.4	5.7	9.4
$\%(S/N)_{Sys}<(S/N)_{\Sigma SBS}$	88.7	27.1	47.4	43.3	46.8	0	30.9	38.8	56.3	53.2	57.9	42.7

Table 12. Average noise trace amplitude in the period band 0.4 second to 1.4 seconds, normalized to a magnification of 1000K @ 1 cps, for MAP I, MAP II, and Primary systems; from visual noise measurements

System	Primary		MAP I				MAP II					
	SZ10	ΣSSF	MCF4	MCF1	MCF3	ΣSBS	MCF11	MCF12	MCF13	MCF14	MCF16	BSSV1
Average trace amplitude (mm X10 view @ 1000K)	3.68	1.38	2.10	2.07	2.04	1.99	1.96	1.22	6.88	2.18	2.12	0.79

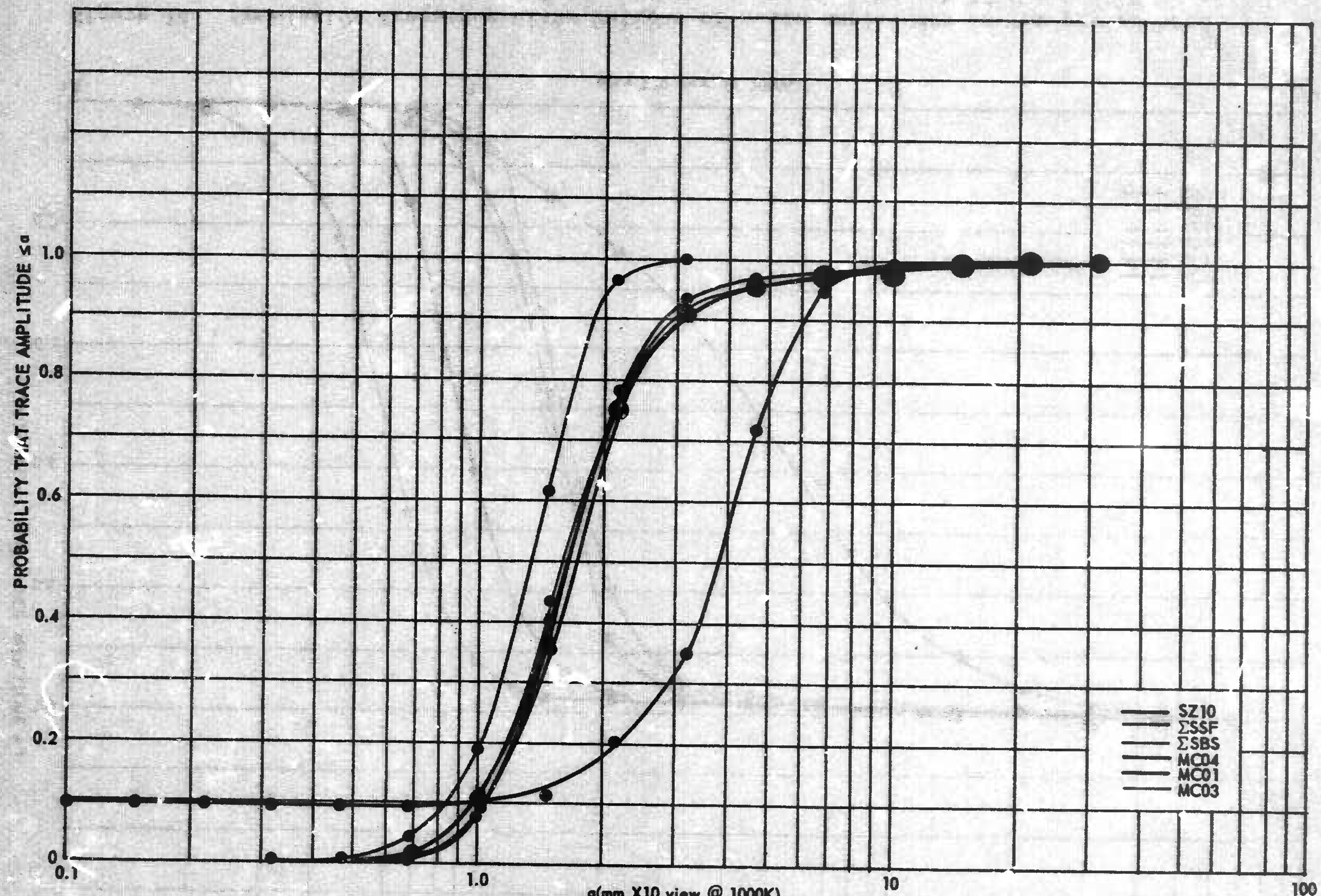

Figure 13. Cumulative frequency distributions of noise amplitudes in the period band 0.4-1.4 seconds recorded by MAP I and Primary systems, 1 January through 12 March 1967

G 2995

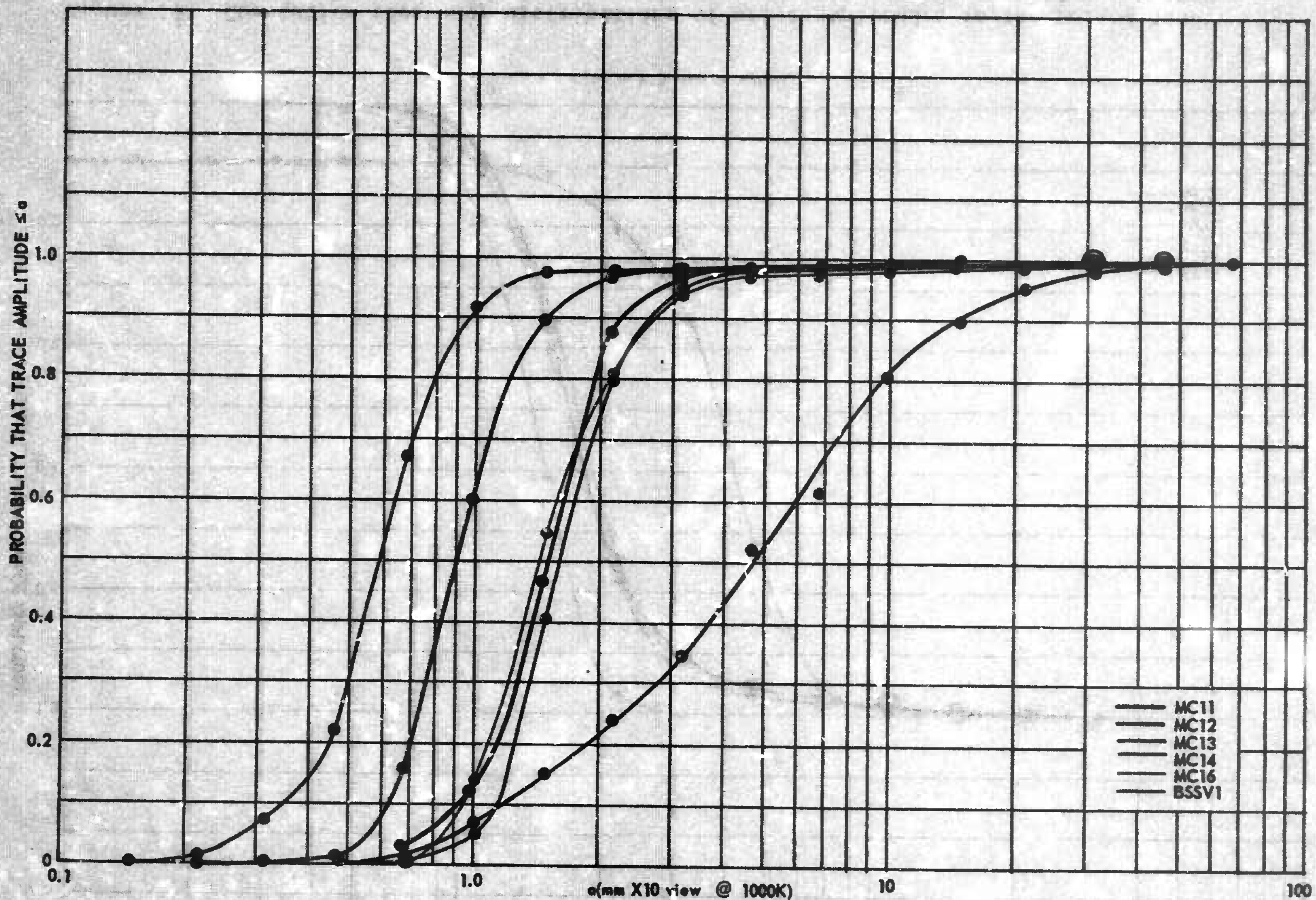

Figure 14. Cumulative frequency distributions of noise amplitudes in the period band 0.4-1.4 seconds recorded by MAP II systems, 1 January through 12 March 1967

G 2996

9.1.4 Noise Power Spectra

Computation of power spectral density estimates for four samples of noise recorded on MCF's 1, 3, 4, 11, 12, and 13 was approximately 50 percent complete at the end of the reporting period.

9.1.5 Detection Capability Comparison

Visual analysis of 16-millimeter film seismograms for the detection capability comparisons was about 90 percent complete at the end of the reporting period. Approximately 500 events will be included in this part of the MAP evaluation. The results of this study will be used to evaluate the detection capabilities of the MAP I and MAP II systems relative to the primary data system.

9.2 SIGNAL CLASSIFICATION STUDY

Evaluation of the signal-classification system continued during the reporting period. Composite 16-millimeter films containing recordings of 315 signals which have been classified by Garland analysts were sent to UBSO and TFSO for classification by observatory analysts. Results of this study will help determine the consistency of signal classifications made by different analysts and evaluate the effectiveness of the system as a hierarchical classification scheme.

9.3 LONG-PERIOD ARRAY INVESTIGATION

On 10 May, we received a request from the Project Officer that we expedite the long-period array program at UBSO and that we redirect as many Contract 16563 funds as possible, proceeding with all preliminary work on this assignment under task a(2) of the current contract. On 19 May, we submitted a proposal (P-965) to Aeronautical Systems Division (ASWKS) for operation of UBSO through October 1968 and to install a 7-element, 3-component long-period array in the vicinity of UBSO, in response to Request for Quotation F33657-67-Q-1490 PA VELA T/6705, Amendment 2. On 19 July, we submitted a revised proposal (P1-965), incorporating the changes requested in the AFTAC technical evaluation of our 19 May proposal.

As of the end of the reporting period, the six long-period vault sites required, in addition to the long-period vault at UBSO, have been selected, and we plan to start test drilling in late August or early September. Five of the sites are located on Bureau of Land Management (BLM) acreage, and the sixth site (LP6) is located on an Indian reservation. Legal descriptions and ownership of the sites are given in table 13. The township and range designators used in the descriptions of the sites located on BLM land are relative to the Salt Lake Base Line and the Salt Lake Meridian (SLBM), respectively. The township and range designators for LP6 are relative to the Uinta Meridian and a special base line established in the Uintah Special Survey - Ute Indian Tribe. All sites are located in Uintah County, Utah. We do not expect to encounter any difficulties in obtaining withdrawal of the required BLM acreage or in negotiating a lease agreement with the Ute Indian Tribe for LP6; we plan to ask the Project Officer to assist us in this matter.

All seismometers had been delivered to UBSO by the end of the reporting period. All equipment, except amplifiers, had been ordered. If the proposed amplifiers are used, we do not expect any delay in installation of the long-period array.

During Dr. Pilotte's visit to our Garland office on 24 and 25 July, we discussed with him the possibility of using gain-ranging amplifiers and digital data transmission to test the equipment and processes for possible use in other arrays.

Table 13. Descriptions of proposed sites for the UBSO long-period array

Site	Description
LP1	SW1/4 SE1/4 SE1/4 Sec 9 T8S R20E SLBM BLM
LP2	NE1/4 NE1/4 NE1/4 Sec 35 T7S R22E SLBM BLM
LP3	NE1/4 SE1/4 NW1/4 Sec 26 T5S R23E SLBM BLM
LP4	SE1/4 SW1/4 SE1/4 Sec 29 T3S R22E SLBM BLM
LP5	SW1/4 (14.8 acres) NE1/4 Sec 12 T4S R19E SLBM BLM
LP6	All land south of county road in SE1/4 NE1/4 NE1/4 Sec 26 T2S R1E Uintah Special Survey - Ute Indian Tribe

9.4 ROUTINE NOISE MEASUREMENTS

Measurements of ambient noise in the 0.4 to 1.4 seconds period range are made daily at UBSO. Data are processed in Garland, and monthly cumulative probability curves of trace amplitude and ground displacement are published. Noise data are reported from the Z10, SZ10, ΣS, ΣSF, ΣSS, and ΣSSF seismograms. Noise curves for March, April, and May 1967 were sent to the Project Officer during this reporting period.

10. PROVIDE OBSERVATORY FACILITIES AND ASSISTANCE TO OTHER ORGANIZATIONS

10.1 DATA SENT TO THE UNIVERSITY OF UTAH

On 12 July, data concerning a blast at Bingham Mine which occurred on 6 July were sent to Mr. Larry Wilson, University of Utah, at Mr. Wilson's request.

10.2 VISITORS

On 2 and 3 May, Sandia representatives, James Linn and E. D. Zaffery, were at UBSO troubleshooting the USO.

On 18 and 19 May, Mr. B. B. Leichliter, Program Manager, and Mr. M. E. Robinson, Garland technical support group, visited UBSO to review the status of current work and plan future programs.

On 12 June, Mr. Floyd Wilson, Petty Geophysical Co., visited UBSO to determine the feasibility of conducting a seismic reflection survey of the array area as part of a commercial oil exploration program.

Sandia representatives, E. D. Zaffery, V. W. Hansen, and E. R. Stepka, were at UBSO on 27 and 28 June working on the USO.

Mr. Noel Doss, Geotech, was at UBSO between 20 June and 12 July, and Mr. John Wise, Geotech, was at UBSO from 6 through 12 July, working on the vertical array.

Messrs. J. N. Murdock and R. E. Humphrey, Environmental Sciences Service Administration - EML, were at UBSO on 9 and 10 July to perform field tests of a portable seismograph.

Dr. Frank Pilotte of the VELA Seismological Center, Mr. B. B. Leichliter, Geotech Program Manager, and Mr. J. M. Whalen, Geotech Geophysical Operations Department Manager, visited UBSO on 28 and 29 July to review the status of Project VT/6705.

11. REPORTS

Technical Report No. 67-31, Operation of UBSO, Quarterly Report No. 4, Project VT/6705, was mailed to the Project Officer on 26 May.

12. REFERENCES

The Geotechnical Corporation, 1964, Deep-Hole Site Report, U.S.A. No. 1, Uintah County, Utah: Garland, Texas, Technical Report No. 64-101

Shappee, Richard M., and Douze, Eduard J., 1967, Final Report, Project VT/5051, Deep-Well Research: Geotech, A Teledyne Company, Garland, Texas, Technical Report No. 67-3

APPENDIX to TECHNICAL REPORT NO. 67-46

STATEMENT OF WORK TO BE DONE

EXHIBIT "A"

STATEMENT OF WORK TO BE DONE

AFTAC Project Authorization No. VELA T/6705/S/ASD (32)

1. Tasks: 8 February 1966

a. Operation:

(1) Continue operation of the Uinta Basin Seismological Observatory (UBSO), normally recording data continuously.

(2) Evaluate the seismic data to determine optimum operational characteristics and make changes in the operating parameters as may be required to provide the most effective observatory possible. Addition and modification of instrumentation are within the scope of work. However, such instrument modifications and additions, data evaluation, and major parameter changes are subject to the prior approval of AFTAC.

(3) Conduct daily analysis of seismic data at the observatory and transmit daily seismic reports to the US Coast and Geodetic Survey, Wash DC 20230, using the established report format and detailed instructions.

(4) Record the results of daily analysis on magnetic tape in a format compatible with the automated bulletin program used by the Seismic Data Laboratory (SDL) in their preparation of the seismological bulletin of the VELA-UNIFORM seismological observatories. The format should be established by coordination with SDL through AFTAC. The schedule of routine shipments of these prepared magnetic tapes to SDL will be established by AFTAC.

(5) Establish quality control procedures and conduct quality control, as necessary, to assure the recording of high quality data on both magnetic tape and film. Past experience indicated that quality control review of one magnetic tape per magnetic tape recorder at the observatory each week is satisfactory unless quality control tolerances have been exceeded and the necessity of additional quality control arises. Quality control of magnetic tape should include, but need not necessarily be limited to, the following items:

(a) Completeness and accuracy of operation logs.

(b) Accuracy of observatory measurements of system noise and equivalent ground motion.

(c) Quality and completeness of voice comments.

(d) Examination of all calibrations to assure that clipping does not occur.

(e) Determination of relative phase shift on all array seismographs.

(f) Measurement of DC unbalance.

(g) Presence and accuracy of tape calibration and alignment.

(h) Check of uncompensated noise on each channel.

(i) Check of uncompensated signal-to-noise of channel 7.

(j) Check of general strength and quality of timing data derived from National Bureau of Standards Station WWV.

(k) Check of time pulse modulated 60 cps on channel 14 for adequate signal level and for presence of time pulses.

(l) Check of synchronization of digital time encoder with WWV.

(6) Provide observatory facilities, accompanying technical assistance by observatory personnel, and seismological data to requesting organizations and individuals after approval by AFTAC.

(7) Maintain, repair, protect, and preserve the facilities of the seismological observatory in good physical condition in accordance with sound industrial practice.

b. <u>Instrument Evaluation</u>: After approval by AFTAC, evaluate the performance characteristics of experimental or off-the-shelf equipment offering potential improvement in the performance of observatory seismograph systems. Operation and test of such instrumentation under field conditions should normally be preceded by laboratory test and evaluation.

c. <u>Special Investigations</u>: Conduct research investigations as approved or requested by AFTAC to obtain fundamental information which will lead to improvements in the detection capability of UBSO. These programs should take advantage of geological, meteorological, and seismological conditions at UBSO. The following special studies should be accomplished.

(1) Long term evaluation of the multiple array processor units.

(2) Installation and evaluation of a vertical array.

(3) Evaluation of the long-period vault.

(4) Provide technical assistance and monitor an unattended seismological observatory to be installed at UBSO in June 1967.

Research might pursue investigations in, but is not necessarily limited to, the following areas of interest: microseismic noise, signal characteristics, data presentation, detection threshold, and array design (surface and shallow borehole). Prior to commencing any research

investigation, AFTAC approval of the proposed investigation and of a comprehensive program outline of the intended research must be obtained.

2. Approval by AFTAC will normally be provided through the project officer.

3. Reports: Provide reports in accordance with the/Data requirements outlined in DD Form 1423 and attachment 1 thereto.

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) GEOTECH, A Teledyne Company 3401 Shiloh Road Garland, Texas	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE
Operation of UBSO
Quarterly Report No. 5, Project VT/6705, 1 May 1967 through 31 July 1967

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Quarterly Report No. 5, Project VT/6705, 1 May 1967 through 31 July 1967

5. AUTHOR(S) (Last name, first name, initial)
Leichliter, B. B.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
17 August 1967	48	2

8a. CONTRACT OR GRANT NO. AF 33(657)-16563	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO. VELA T/6705	Technical Report No. 67-46
c. ARPA Order No. 624	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d. ARPA Program Code No. 6F10	

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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Advanced Research Projects Agency Nuclear Test Detection Office Washington, D.C.

13. ABSTRACT

This report describes the operation of the Uinta Basin Seismological Observatory (UBSO) from 1 May 1967 through 31 July 1967. Modifications and additions to the observatory instrumentation are described, and tests to improve the operations of the observatory are reported. Also discussed is the status of special investigations designed to evaluate and improve the detection capability of the observatory.

DD FORM 1 JAN 64 1473

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Unattended Seismological Observatory						
Vertical Array						
Multiple Array Processor						
Seismograph Operating Parameters						
Long-Period Array						

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